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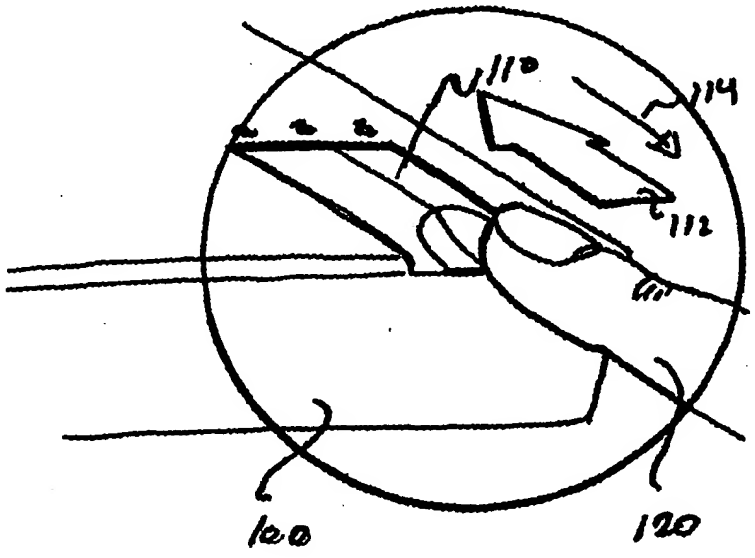
(54) Title: A PROTECTIVE ENCLOSURE FOR SENSOR DEVICES

(57) Abstract

The present invention encloses a biometric sensor for sensing fingerprints. The enclosure (100) comprises a movable access piece (110) positionable at a plurality of positions. A sensor (130) is mounted relative to the access piece, and the access piece (110) is slidable to reveal the sensor. When the access piece (110) is in the closed position, the sensor (130) is completely enclosed and thereby protected from impacts. To access the sensor (130), the user slides the access piece (110) to an open position using the finger (120) he wishes to place on the sensor. When the access piece (110) reaches the fully opened position, the fingerprint is aligned with the sensor (130). The access piece (110) is made from a conductive material, and it is also electrically grounded. Since the user must touch the access piece (110) to reveal the sensor (130), the user is electrostatically discharged before accessing the sensor.



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# A PROTECTIVE ENCLOSURE FOR SENSOR DEVICES

## FIELD OF THE INVENTION

The present invention relates to enclosures for sensor devices, and more particularly to a protective enclosure which aligns an object placed on a biometric sensor.

## BACKGROUND OF THE INVENTION

Biometric-oriented personal identification techniques are becoming increasingly important in protecting personal property, such as laptop computers and cellular phones, preventing credit card and calling card fraud, limiting access to security areas, computers and information, and ensuring security for electronic commerce. Biometric identification techniques use physical traits, measurements and characteristics specific to an individual. These characteristics include, but are not limited to, voice prints, hand prints, fingerprints, retina patterns, and signatures. Typically, biometric identification and verification techniques compare an individual's stored biometric data (the enrolled data) against newly obtained biometric data when the individual desires use of a protected item, access to a protected area or access to protected information. Due to its inherent nature, biometric data has the advantage of always being available for user identification and verification.

The fingerprint biometric is one of the most widely used and researched biometric identification techniques. Existing technology allows the relevant features of a fingerprint to be represented in a few hundred bytes of data. Furthermore, the

computer hardware required for recording and comparing fingerprint data can be centralized and accessed through a telecommunications network, centralized databases and processing hardware, with the result that costs may be amortized across many more transactions than would be the case for distributed processing.

There are, however, disadvantages to biometric identification and verification. For instance, biometric sensors are susceptible to damage from impacts. Also, solid-state biometric sensors are susceptible to damage from electrostatic discharge. In fingerprint identification, the sensor may be particularly susceptible to electrostatic discharge, because the user touches the sensor during the sensing operation.

There are also problems associated with acquiring an accurate image of the fingerprint when an individual desires to access a protected item. In a typical enrollment procedure, the user centers the core of the fingerprint on the sensor, because the core provides desirable identification characteristics. Due to the relatively small size of most fingerprint sensors, often as small as 0.6 inches x 0.6 inches (150 mm x 150 mm), little, if any, of the rest of the fingerprint is sensed by the sensor. During an access procedure, users instinctively place their finger tips on the sensor. When a user places a portion of a fingerprint on the sensor which does not overlap the enrolled image, access will be denied due to finger placement error.

Accordingly, a device is needed for protecting the sensor from impacts, from electrostatic discharge and from other potentially harmful foreign materials, such as dust, dirt, sunlight and liquids. There is also a need for a device and method for aligning a finger on the sensor to ensure overlap with the enrolled image.

## SUMMARY OF THE INVENTION

The present invention increases accuracy and reliability of biometric identification and verification techniques while protecting a sensor from harmful impacts and electrostatic discharge. Such protection and increased accuracy and reliability are achieved by providing an enclosure comprising a movable access piece made from a conductive material. When the access piece is positioned to reveal the sensor, the walls of the enclosure, together with the access piece, cause the user to properly align the object of interest (usually a finger) with the sensor. Protection from electrostatic discharge is achieved by grounding the access piece, which the user must move to reveal the sensor. When the sensor is not in use, the access piece is closed, protecting the sensor from harmful impacts.

In an exemplary embodiment, the present invention encloses a biometric sensor for sensing fingerprints. The sensor is mounted relative to an access piece, and the access piece is slidable to reveal the sensor. When the access piece is in the closed position, the sensor is completely enclosed. To access the sensor, the user slides the access piece to an open position using the finger he wishes to place on the sensor. When the access piece reaches the fully opened position, the desired portion of the fingerprint is aligned with the sensor. The access piece is made from a conductive material, and it is electrically grounded. Since the user must touch the access piece to reveal the sensor, the user is electrostatically discharged before accessing the sensor.

## BRIEF DESCRIPTION OF THE FIGURES

For a better understanding of the present invention, reference may be had to the following description of exemplary embodiments thereof, considered in conjunction with the accompanying drawings, in which:

FIG. 1A shows one view of an exemplary enclosure;

FIG. 1B shows a cross-sectional view of the enclosure of FIG. 1A;

FIG. 1C shows another cross-sectional view of the enclosure of FIG. 1A;

FIG. 1D shows a top view of the enclosure of FIG. 1A;

FIG. 1E shows another view of an exemplary enclosure;

FIG. 2 shows a side view of an exemplary enclosure;

FIG. 3 shows a top view of an exemplary enclosure;

FIG. 4A and 4B show a side view and a perspective view of an exemplary enclosure;

FIG. 5A, 5B, 5C and 5D show a top view of an exemplary enclosure with an access piece positionable at a plurality of positions;

FIG. 6 shows a fingerprint image enrolled according to a method of the invention;

FIG. 7 shows a flow chart illustrating one exemplary method of operating a sensor according to the invention; and,

FIG. 8A and 8B show another exemplary embodiment.

## DETAILED DESCRIPTION OF THE DRAWINGS

The present invention provides an apparatus and method for enclosing and operating a biometric sensor. An enclosure according to the invention protects the sensor from harmful impacts, from electrostatic discharges (ESDs) and from other harmful material and electromagnetic energy. In the preferred embodiment, the enclosure protects a biometric sensor used for sensing fingerprints, and the enclosure is configured to cause a user to align the fingerprint core with the sensor during an access procedure. The enclosure of the invention is also used during enrollment, and a method is provided for enrolling and reconstructing a fingerprint image which increases the likelihood of image overlap during an access procedure. Also, an apparatus is provided for indicating to the user when a fingerprint image of adequate quality is captured.

The preferred embodiment of the enclosure according to the invention is shown in FIG. 1A. The enclosure 100 comprises an access piece 110 which is shown in the closed position. The access piece 110 is a sliding door, and is movable in the direction of the arrows 112 and 114. A cross-section of the enclosure 100 with the access piece 110 in a closed position is shown in FIG. 1B. A sensor 130 is mounted in the enclosure 100 such that the closed access piece 110 covers the sensor 130, thereby protecting it from impacts. An exemplary embodiment of a fingerprint sensor device 130 that can be used in conjunction with the present invention is explained in

U.S. Patent Application "Capacitive Fingerprint Sensor Device With Adjustable Gain," filed May 13, 1997 describing a method and an apparatus for detecting a fingerprint from a finger surface. The apparatus includes a planar array of capacitive sense elements disposed on a substrate. It also includes an insulating and receiving surface disposed over the array of sense elements, which is adapted to receive a finger so that a sense element and a portion of the finger surface located thereabove create a measurable change in capacitance. The capacitance is measured by first pre-charging each sense element, and then using a known current source to remove a fixed amount of charge from each capacitor plate. After a fingerprint is acquired, the quality of the fingerprint is evaluated, and if necessary, a gain parameter for the sense elements is iteratively adjusted until a satisfactory fingerprint is acquired.

Operation of the enclosure 100 is described with reference to FIG. 1A, FIG. 1B and FIG. 1C. A user accesses the sensor 130 by placing a finger 120 on the access piece 110 and moving it in the direction of the arrow 112. In this position, the sensor 130 is fully revealed, as shown in FIG. 1C, and the finger 120 has access to the sensor 130. The finger 120 will then be disposed on the sensor 130 in a proper position and the sensing operation may proceed. A spring (not shown) attaches the access piece 110 to the enclosure 100 such that the access piece 110 closes (is returned to the closed position) when the user releases the access piece 110.

To overcome the hazards of ESD to the sensor 130, especially during an access procedure, the access piece 110 is made of a conductive material and is electrically grounded. When a user touches the access piece 110 to access the sensor

130, the user is grounded through the access piece 110. Because the finger 120 must continue to apply pressure to the access piece 110 to overcome the force of the spring, the finger 120 remains grounded throughout the sensing operation. Once the user releases the access piece 110, it automatically closes, thereby enclosing the sensor 130.

One exemplary spring configuration is shown in FIG. 1E. The spring 180 is a coil spring with elongated ends, each end having a hook. At one end, the spring 180 is hooked to a coupling protrusion 181 on the access piece 110. The other end is hooked to the enclosure 100 at an aperture 183. When the spring 180 is relaxed (that is, not under tension), the access piece 110 is closed. To open the access piece 110, the user must overcome the force of the spring 180. Upon release, the spring 180 returns the access piece 110 to the closed position.

As shown in FIG. 1E, the enclosure further comprises means for mechanically fastening the enclosure 100 to some other device, such as a laptop computer. In the illustrated embodiment, the fastening means include a locating pin 189 and fastening holes 187 and 189. The locating pin 189 fits in a corresponding hole in the device of interest to locate the enclosure 100 in the desired position. Fastening holes 187 and 189 are configured to accept a corresponding fastening means, such as a screw.

A switch 160 attached to the enclosure 100 is also provided. Preferably the switch 160 is operable to switch power to the sensor on and off. The switch 160 is positioned relative to the access piece 110 so that the access piece 110 engages the switch when the user slides the access piece 110 to access the sensor (not shown).

When the user releases the access piece 110, the spring 180 causes the access piece 110 to return to the closed position. After the movement to the closed position, the access piece 110 disengages the switch 160 thereby turning off power to the sensor (not shown).

It is another advantage of this enclosure 100 that the access piece 110 is configured to stop in a position which aligns the finger 120 with the sensor 130. Referring to the cross-section of the access piece shown in FIG. 1B, the access piece 110 is shaped to form a fingertip contour 113. As a user approaches the enclosure 100 to access the sensor 130, the user intuitively touches the access piece 110 in this contoured area 113 with the finger tip, because the fingertip naturally fits into the area 113. As shown in FIG. 1C, when the access piece 110 is moved to an open position with the fingertip placed in the contoured area 113, the top of the finger 120 extends beyond the sensor 130 and the fingerprint core is aligned with the sensor 130.

Lateral alignment of the finger 120 on the sensor 130 is shown with reference to FIG. 1D. The enclosure 100 comprises guides 122 and 124 spaced apart by a predetermined width, preferably the width of the finger 120. In the enclosure 100, the guides 122 and 124 are molded plastic walls. To accommodate fingers of various sizes, the walls may also be slanted inwardly from top to bottom; that is, toward the sensor. When the user places the finger 120 on the sensor 130, the guides laterally align the finger 120 on the sensor 130. The alignment provided by the access piece 110 in the open position and by the guides 122 and 124 enhances accuracy and reliability in acquiring the fingerprint image by minimizing finger placement error.

Of course, the access piece may be configured in various ways to protect sensors designed for various uses. For instance, with reference to FIG. 2, a side view of an enclosure 200 comprising a hinged 202, 204 and 206 access piece 210 is shown. The access piece 210 is made from a conductive material, and it is positionable at a closed position 212 and an open position 214. In the closed position 212, a sensor 220 is covered, protecting it 220 from impacts. To move the access piece 210, the user pushes the piece 210 with his finger to the open position 214. The same previously described alignment and grounding features may be provided.

The top view of another embodiment is shown in FIG. 3. The enclosure 300 comprises a rotatable access piece 310 which is positionable at a closed position 312 and at an open position 314. The user operates the access piece 310 by rotating it with his finger about a pivot 311 to the open position 314. The sensor 316 is revealed when the access piece 310 is at the open position 314. As in the preferred embodiment, the access piece 310 is electrically conductive to ground, and is configured to return to the closed position when the user releases the access piece 310.

Still another configuration is shown in FIG. 4A. An enclosure 400 comprises a housing 410 with an access end 412 and a closed end 414. The housing 410 protects a sensor 420 from impacts when the sensor 420 is not in use. An access piece 430 covers the access end 412. The access piece 430 is made from a conductive material and is swingable between a closed position (not shown) and an open position. The user accesses the sensor 420 by pushing on the access piece 430 with his finger. The access piece 430 is grounded, thereby protecting the sensor 420 from ESD.

Preferably, the housing 410 is shaped such that a finger placed within the housing is laterally aligned with the sensor 420. In this embodiment, the closed end 414 of the housing 410 acts as a stop, causing the user to align his finger with the sensor 420 such that the core of the fingerprint is on the sensor 420.

A perspective of this configuration is shown in FIG. 4B. Walls 413 and 415 laterally constrain the finger (not shown) such that the finger is laterally aligned on the sensor 420. The closed end 414 acts as a constraint causing the fingerprint core to locate on the sensor 414. The access piece 430 is grounded to protect the sensor 420 from electrostatic discharge.

In still another configuration, the sensor is mounted in a slidable unit. As shown in FIG. 8A and FIG. 8B, the enclosure 800 comprises a sliding unit 810. In the closed position, the sliding unit 810 resides within the enclosure 800 and the sensor 820 is protected. An access piece 812, which is a button in this configuration, is operable to cause the sliding unit 810 to slide out of the enclosure 800. The means for sliding the sliding unit 810 into and out of the enclosure 800 may be a spring or motor. As in the prior configurations, the button 812 is electrically conductive to a ground. The user is grounded when he presses the button 812 to release the sliding unit 810. An enclosure edge 817 constrains the finger in one direction and sliding unit edges 819 and 821 constrain the finger in a second and third direction.

An enclosure according to the invention is also provided with an access piece positionable at a plurality of positions. Referring to FIG. 5A, an enclosure 500 is shown with an access piece 510 in a closed position, completely covering the sensor

(not shown). The enclosure also comprises a stopper 530 which is operable to stop the access piece 510 at an open position. An arrow 535 marks a position on the enclosure 500, and a "1" and a "2," or other such alignment marks, mark two positions on the access piece 510. By aligning the access piece 510 markers "1" or "2" with the arrow 535, the access piece 510, in this case a sliding door, is positionable at multiple predetermined positions.

This multiple position capability enables capture of different portions of the fingerprint during enrollment. Enrollment is the procedure by which a fingerprint image is captured and stored as computer accessible data. In FIG. 5B, the enclosure 500 is shown with the access piece 510 positioned at position "1." Only the tip of the finger 540 extends beyond the sensor 520, and the finger 540 and sensor 520 are positioned such that the top of the fingerprint image may be captured. FIG. 5C shows the relative positions of the sensor 520, access piece 510 and finger 540 when the access piece 510 is at position "2." The finger 540 is positioned such that the fingerprint core is centered on the sensor 520, permitting capture of this portion of the fingerprint. In FIG. 5D, the access piece 510 is pushed to the stopper 530, and the finger 540 and sensor 520 are positioned such that an image of the bottom of the fingerprint may be captured.

This procedure enables enrollment and reconstruction of a fingerprint image which comprises the combination of the images captured in position "1," position "2," and at the stop 530 position. This reconstructed image is known as a virtual image. This virtual image is advantageously larger than the sensor area. For example, the

virtual image 600 of FIG. 6 was captured and reconstructed according to the just-described procedure. As can be seen, the virtual image 600 is the combination of three overlapping images 611, 612 and 613 each of which is the size of the sensor.

Advantageously, the resulting image 600 has a larger area than the sensor. When a user places a finger on the sensor during an access procedure, alignment errors are overcome by the relatively larger area of the virtual image 600. In other words, the described apparatus and method increases the probability that the portion of the fingerprint placed on the sensor during an access procedure overlaps the enrolled image 600.

The advantages in overcoming finger placement error with the alignment features of the invention are further enhanced with an image quality indicator, which informs the user when an acceptable image has been captured. A method for providing an image quality indicator is described with reference to the flow chart 700 of FIG 7. In a first step 710 of the procedure, the finger is placed on a sensor enclosed with the previously described apparatus. In a process step 720, the fingerprint image is captured. Then the quality of the image is evaluated in a decision step 730, and it is determined whether the image quality is adequate. If the image is adequate, the user is advised in a process step 740 that the image has been captured. When the image is inadequate, control returns to the process step 720 and the procedure is repeated.

For purposes of this quality indicator feature of the present invention, it is unimportant how an image is captured. Image capturing and storing techniques are well known in the art. Similarly, the image quality may be measured in many ways.

For instance, contrast is one know attribute commonly used for evaluating an image; the image is evaluated by how well the intensity range of the image stretches over the maximum intensity range available. Image evaluation is described in W.K. Pratt, "Digital Image Processing," Wiley Press, New York, New York, 1978, pp. 307-318. The process step 740, which informs the user that the image quality is adequate, may also be implemented with various methods and apparatus. For instance, the indication ,may be audible, such as a beep emitted from a speaker, or visual, such as in lighting an LED.

Numerous modifications and alternative embodiments of the invention will be apparent to those skilled in the art in view of the foregoing description. For instance, an enclosure according to the invention is also operable to protect the sensor from dirt, dust or liquids. Similarly, the enclosure and access piece may also comprise a radio frequency shield to protect the sensor from electromagnetic energy. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the best mode of carrying out the invention. Details of the structure may be varied substantially without departing from the spirit of the invention and the exclusive use of all modifications which come within the scope of the appended claims are reserved.

**WHAT IS CLAIMED IS:**

1. A protective enclosure for a sensor, comprising:

an electrically conductive access piece positionable between a closed position and at least one open position, said access piece substantially covering the sensor at said closed position and said access piece substantially revealing the sensor at said open position; and,

means for grounding said access piece, wherein an object is substantially grounded upon contacting said access piece.

2. The enclosure of claim 1 further including means for returning said access piece from said open position to said closed position when said access piece is released.

3. The enclosure of claim 2 wherein said means for returning comprises a spring coupled between said access piece and said enclosure, wherein said spring is relaxably coiled when said access piece is at said closed position and said spring is under tension when said access piece is at said open position.

4. The enclosure of claim 1 wherein said access piece is rotatable between said closed position and said open position.

5. The enclosure of claim 1 wherein said access piece is slidable between said closed position and said open position.

6. The enclosure of claim 1 wherein said access piece is swingable between said closed position and said open position.

7. The enclosure of claim 1 wherein said access piece comprises at least one hinge.

8. The enclosure of claim 1 wherein the enclosure is operable to align the object on the sensor.

9. The enclosure of claim 8 wherein said open position is predetermined to align the object with the sensor in a first position.

10. The enclosure of claim 8 wherein the enclosure further comprises means for aligning the object on said sensor in a second position.

11. The enclosure of claim 8 wherein said means for aligning the object on said sensor in said second position further comprises:

a first guide; and,

a second guide, said first guide and said second guide operable to provide alignment for the object on said sensor in said second position.

12. The enclosure of claim 1 wherein said means for grounding said access piece comprises a conductive means electrically connected between said access piece and a ground.

13. The enclosure of claim 1 further comprising a means indicative of image quality.

14. The enclosure of claim 13 wherein said means indicative of image quality comprises:

a processing means for capturing an image;

a decision making means for determining when a quality criteria for said image exceeds a predetermined level; and

a means for informing a user when image quality above said predetermined level has been achieved.

15. The enclosure of claim 14 wherein said means for informing a user when said image quality has been achieved comprises a sound generating device operable to emit a sound when said image quality criteria exceeds said predetermined level.

16. The enclosure of claim 14 wherein said means for informing a user when said image quality has been achieved comprises a light generating device.

17. The enclosure of claim 1 wherein said access piece is positionable at a plurality of positions.

18. The enclosure of claim 1 further comprising a radio frequency shield for protecting the sensor from electromagnetic energy.

19. The enclosure of claim 1 further comprising a switch disposed relative to said access piece, said switch operable to couple the sensor to a power source when said access piece is at said open position and to decouple the sensor from said power source when said access piece is at said closed position.

20. A method for operating a biometric sensor, comprising the steps of:

providing an enclosing means for enclosing said sensor; and,

providing an electrostatically grounded access piece disposed relative to said sensor, said access piece positionable at a closed position and at least one open position, wherein said sensor is substantially covered when said access piece is at said closed position and wherein said sensor is substantially revealed when said access piece is at said open position.

21. The method of claim 20 comprising the further step of moving said access piece from said closed position to said open position to substantially reveal said sensor, wherein said access piece and said enclosing means are operable to align said object on the sensor.

22. The method of claim 20 comprising the further step of returning said access piece from said open position to said closed position.

23. The method of claim 21 wherein said moving step comprises the further step of coupling the sensor to a power source.

24. The method of claim 22 wherein said returning step comprises the further step of decoupling the sensor from a power source.

25. A method for enrolling an image of an object using a biometric sensor, comprising the steps of:

dividing said object into a plurality of portions;

aligning the object on the sensor such that the sensor senses at least one of said portions;

capturing a portion image, said portion image being an image of said at least one portion;

repeating said aligning step and said capturing step until a predetermined number of said portion images are captured; and,

constructing a representation of the image from said portion images.

26. The method of claim 25 wherein said aligning step further comprises the steps of:

providing an enclosing means for enclosing said sensor; and,

providing an access means to said sensor, said access means and said enclosing means operable to align said object on said sensor at a plurality of positions.

27. A protective enclosure for a sensor, comprising:

a sliding unit positionable between a closed position and at least one open position, wherein the sensor is substantially covered at said closed position and the sensor is substantially revealed at said open position;

an electrically conductive access piece operable to cause said sliding unit to move from said closed position to said open position; and,

means for grounding said access piece, wherein an object is substantially grounded upon contacting said access piece.

28. The enclosure of claim 27 further including means for moving said access piece between said open position and said closed position.

29. The enclosure of claim 28 wherein said means for moving comprises a motor.

30. The enclosure of claim 27 wherein said open position is predetermined to align the object with the sensor in a first position.

31. The enclosure of claim 27 wherein the enclosure further comprises means for aligning the object on said sensor in a second position.

32. The enclosure of claim 27 wherein said means for grounding said access piece comprises a conductive means electrically connected between said access piece and a ground.

33. The enclosure of claim 27 further comprising a switch disposed relative to said sliding unit, said switch operable to couple the sensor to a power source when said sliding unit is at said open position and to decouple the sensor from said power source when said sliding unit is at said closed position.

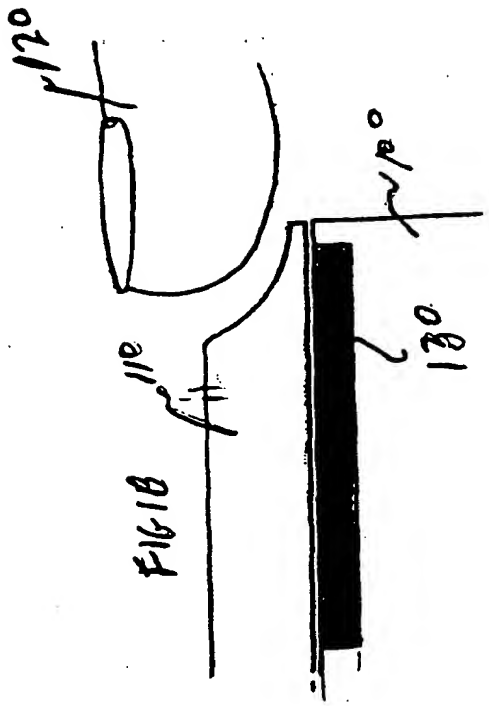



FIG 1B

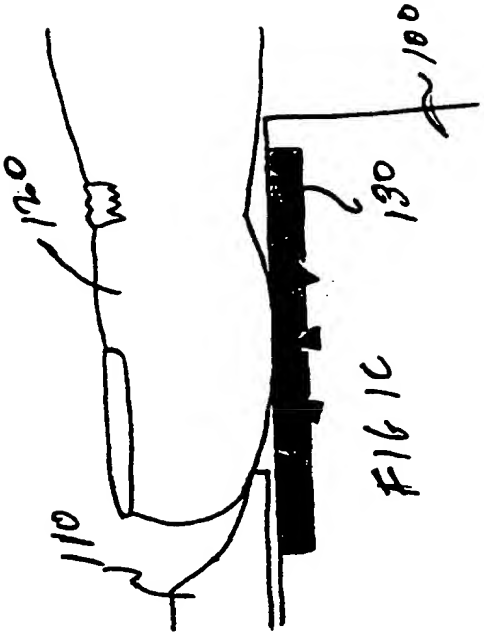



FIG 1C

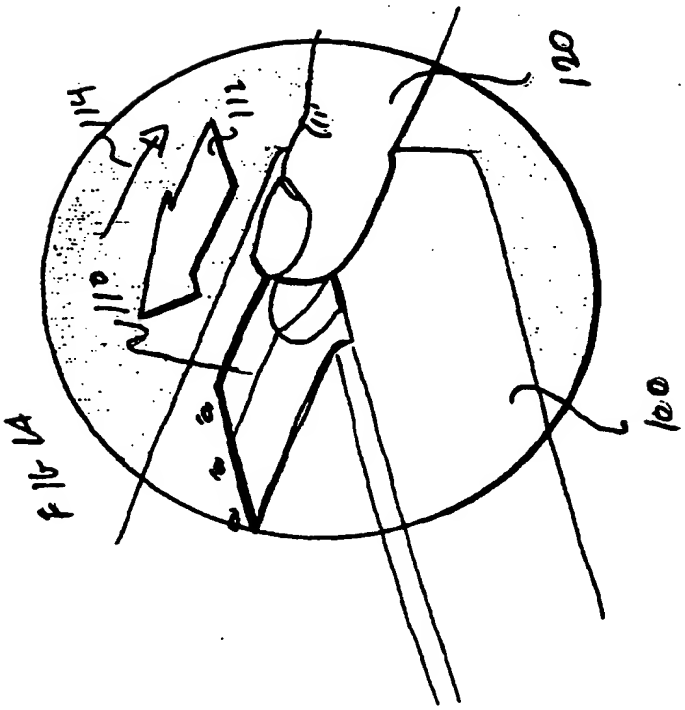



FIG 1A

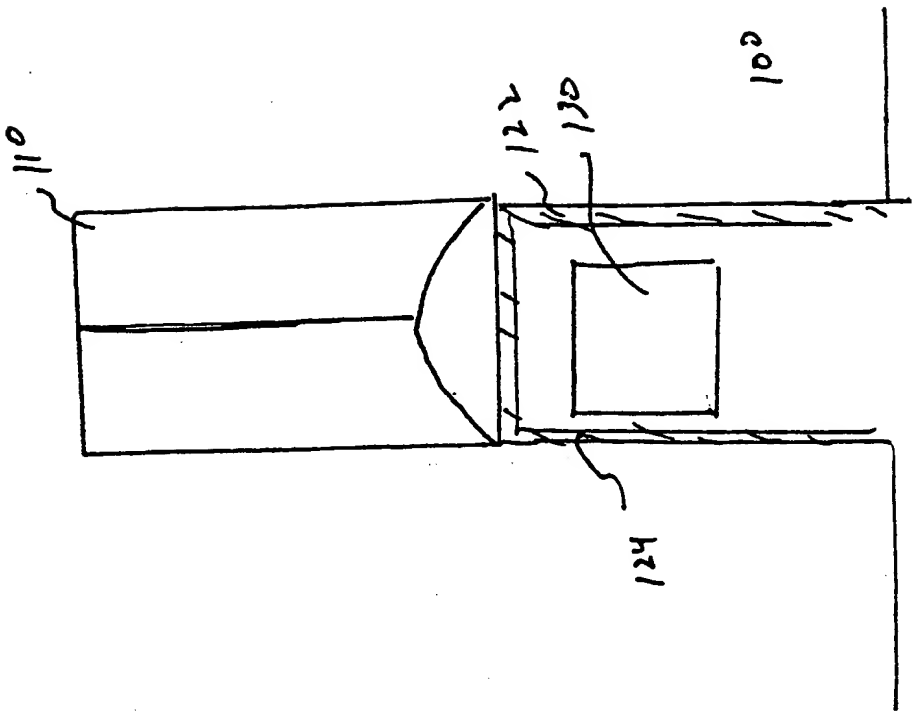



FIG. 12

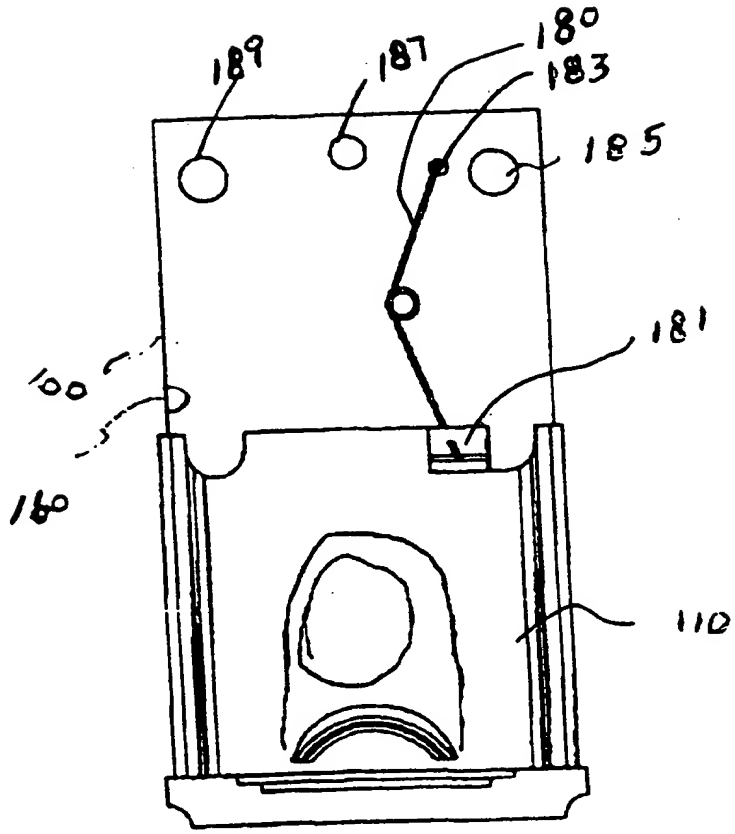



FIG 1E

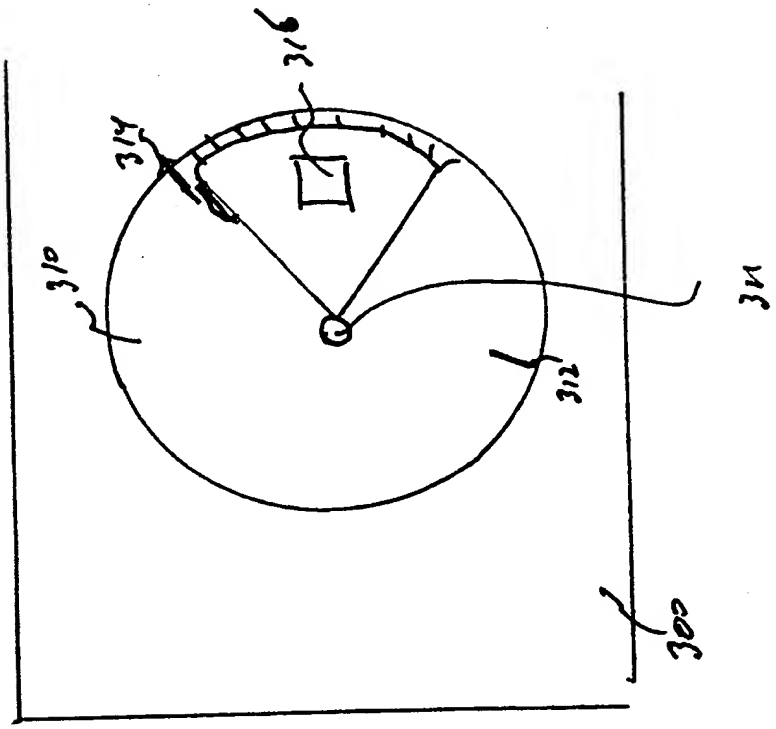



FIG 3

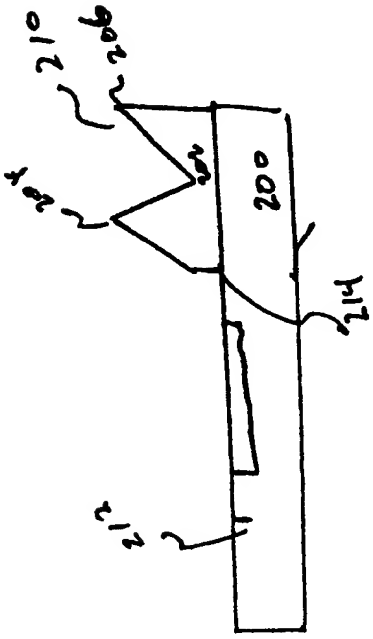



FIG. 2

FIG 4A

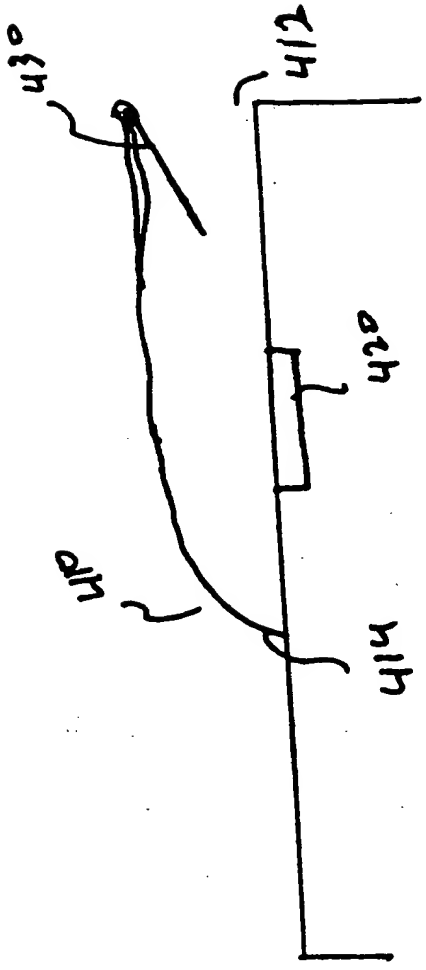
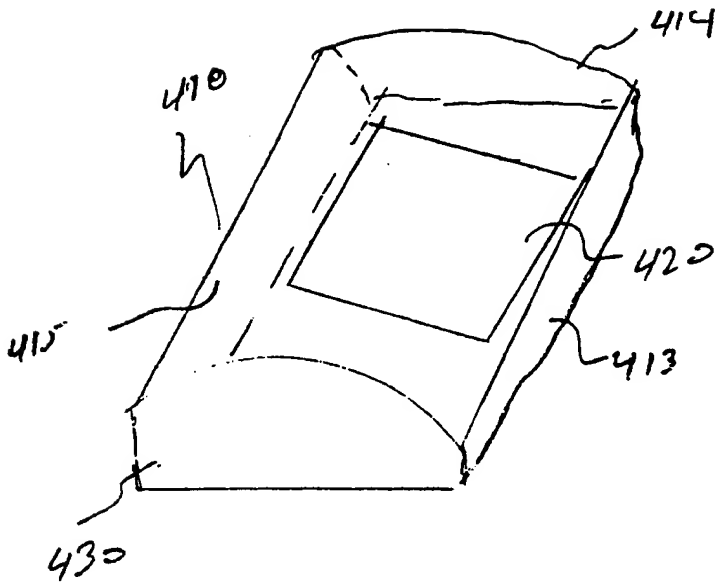


FIG. 4B



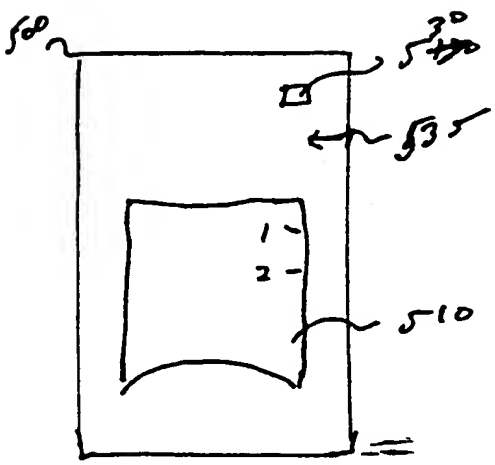



FIG. 5A

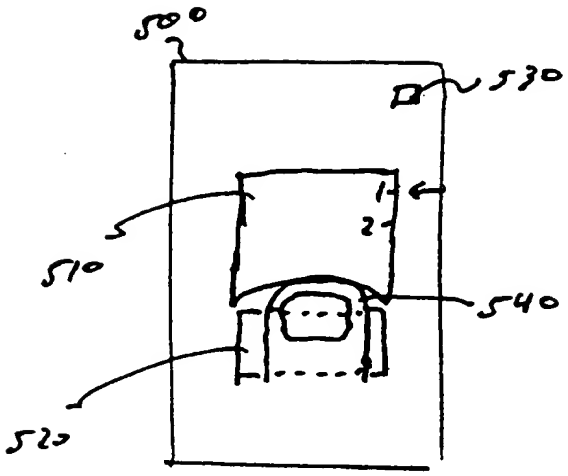



FIG. 5B

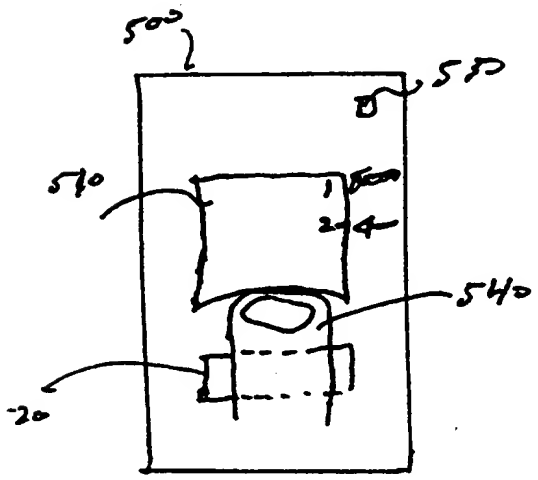



FIG. 5C

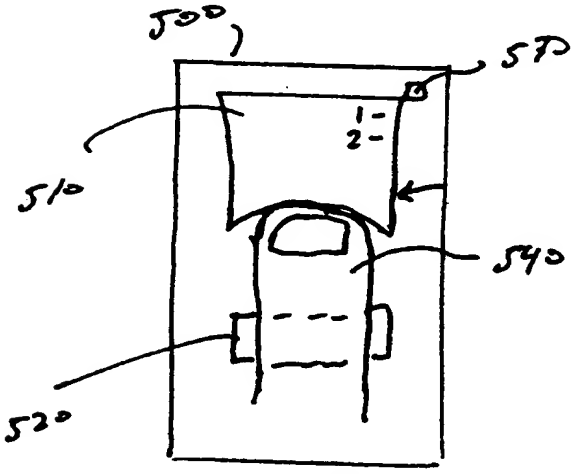



FIG. 5D

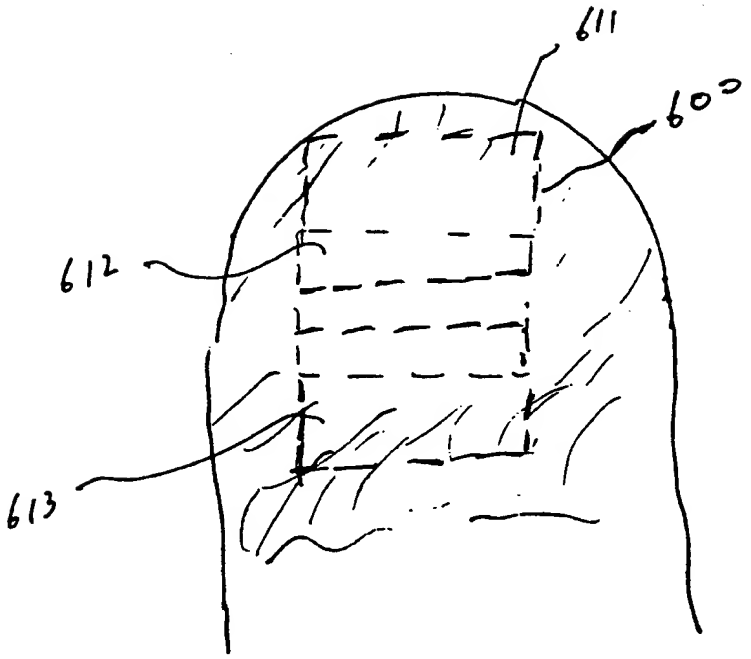



FIG. 6

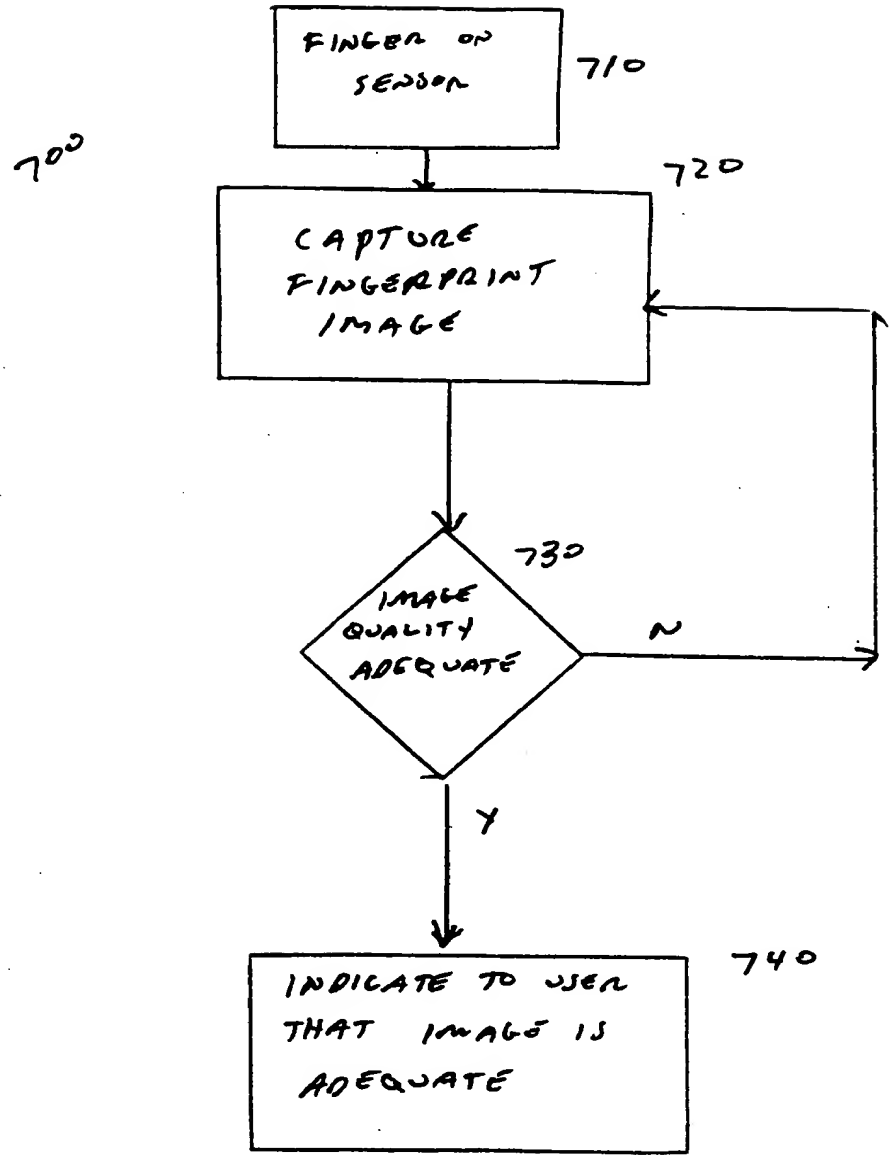



FIG. 7

FIG. 8A

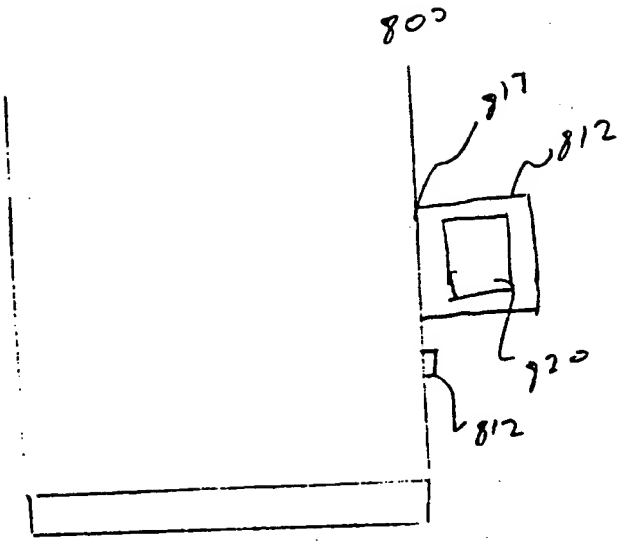
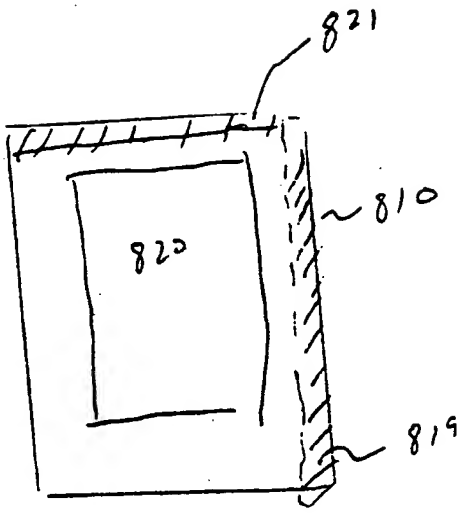



FIG. 8B



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(51) International Patent Classification 7 : A61B 5/117

A3

(11) International Publication Number: WO 00/21439

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09/169,894 12 October 1998 (12.10.98) US

(71) Applicant *(for all designated States except US)*: VERIDICOM, INC. [US/US]; 2338 Walsh Avenue, Santa Clara, CA 95051 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: O'GORMAN, Lawrence [CA/US]; 18 Albright Circle, Madison, NJ 07940 (US). MILLER, Wayne, H. [US/US]; 646 Distel Drive, Los Altos, CA 94022 (US).

(74) Agents: McGEARY, Vincent, E. et al.; Gibbons, Del Deo, Dolan, Griffinger & Vecchione, One Riverfront Plaza, Newark, NJ 07102 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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(88) Date of publication of the international search report:
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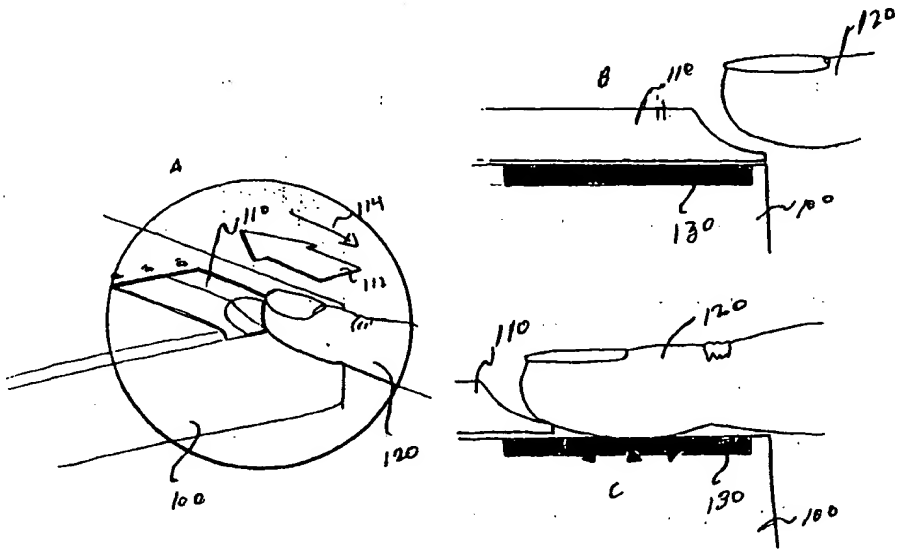
(54) Title: A PROTECTIVE ENCLOSURE FOR SENSOR DEVICES




(57) Abstract

The present invention encloses a biometric sensor for sensing fingerprints. The enclosure (100) comprises a movable access piece (110) positionable at a plurality of positions. A sensor (130) is mounted relative to the access piece, and the access piece (110) is slidable to reveal the sensor. When the access piece (110) is in the closed position, the sensor (130) is completely enclosed and thereby protected from impacts. To access the sensor (130), the user slides the access piece (110) to an open position using the finger (120) he wishes to place on the sensor. When the access piece (110) reaches the fully opened position, the fingerprint is aligned with the sensor (130). The access piece (110) is made from a conductive material, and it is also electrically grounded. Since the user must touch the access piece (110) to reveal the sensor (130), the user is electrostatically discharged before accessing the sensor.

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# INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/US 99/23473

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/117

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B G07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 3 804 524 A (JOCOY K ET AL)<br>16 April 1974 (1974-04-16)<br>column 2, line 29 -column 4, line 4<br>column 6, line 6 - line 20 | 1,20,27 |
| A | GB 1 267 996 A (IDENTIMATION CORP)<br>22 March 1972 (1972-03-22)<br>page 3, line 15 - line 28<br>page 3, line 52 - line 80 | 1,20,27 |
| X | US 5 177 802 A (FUJIMOTO YOSHIJI ET AL)<br>5 January 1993 (1993-01-05) | 25,26 |
| A | column 22, line 7 - line 68 | 1,20,27 |
| A | EP 0 813 164 A (THOMSON CSF)<br>17 December 1997 (1997-12-17)<br>column 9, line 17 -column 10, line 3 | 1,20,25,<br>27 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 19 May 2000 | 08. 06. 2000 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040, Tx. 31 651 epo nl,<br>Fax: (+31–70) 340–3016 | Knüpling, M |

Form PCT/ISA/210 (second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

...ernational application No.
PCT/US 99/23473

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

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2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-24,27-33

   A protective enclosure for a sensor

2. Claims: 25,26

   A method for enrolling an image of an object

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Int tional Application No
PCT/US 99/23473

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 3804524 A | 16-04-1974 | NONE | |
| GB 1267996 A | 22-03-1972 | AT 308435 B | 15-05-1973 |
| | | BE 732862 A | 10-11-1969 |
| | | CH 501280 A | 31-12-1970 |
| | | CS 177014 B | 29-07-1977 |
| | | DE 1923891 A | 20-11-1969 |
| | | DK 144233 B | 25-01-1982 |
| | | FR 2008282 A | 16-01-1970 |
| | | IE 33076 B | 06-03-1974 |
| | | JP 55051579 B | 25-12-1980 |
| | | NL 6907111 A,B, | 12-11-1969 |
| | | NO 126897 B | 09-04-1973 |
| | | SE 358292 B | 30-07-1973 |
| | | US 3576538 A | 27-04-1971 |
| US 5177802 A | 05-01-1993 | JP 4242486 A | 31-08-1992 |
| | | JP 2579375 B | 05-02-1997 |
| | | JP 3256185 A | 14-11-1991 |
| | | JP 2799054 B | 17-09-1998 |
| | | JP 4092990 A | 25-03-1992 |
| | | JP 4120671 A | 21-04-1992 |
| | | JP 2796428 B | 10-09-1998 |
| | | JP 4190470 A | 08-07-1992 |
| EP 0813164 A | 17-12-1997 | FR 2749955 A | 19-12-1997 |
| | | CA 2206825 A | 14-12-1997 |
| | | CN 1172308 A | 04-02-1998 |
| | | JP 10091769 A | 10-04-1998 |

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(25) Filing Language: English

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(71) Applicant *(for all designated States except US)*: **VERIDICOM, INC.** [US/US]; 2338 Walsh Avenue, Santa Clara, CA 95051 (US).

(72) Inventors; and

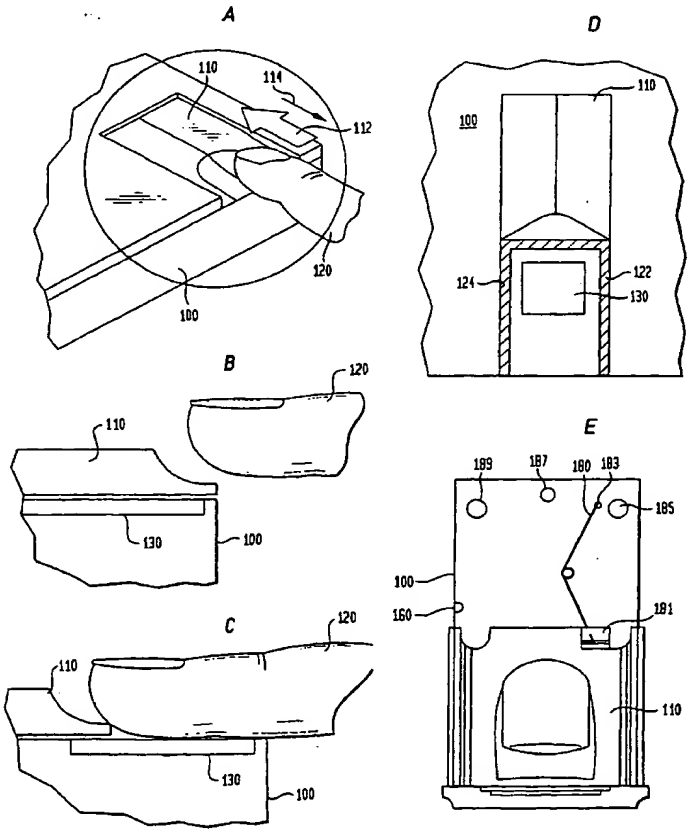
(75) Inventors/Applicants *(for US only)*: **O'GORMAN, Lawrence** [CA/US]; 18 Albright Circle, Madison, NJ 07940 (US). **MILLER, Wayne, H.** [US/US]; 646 Distel Drive, Los Altos, CA 94022 (US).

(74) Agents: **McGEARY, Vincent, E.** et al.; Gibbons, Del Deo, Dolan, Griffinger & Vecchione, One Riverfront Plaza, Newark, NJ 07102 (US).

(81) Designated States *(national)*: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW.

*[Continued on next page]*

(54) Title: A PROTECTIVE ENCLOSURE FOR SENSOR DEVICES




(57) Abstract: The present invention encloses a biometric sensor for sensing fingerprints. The enclosure (100) comprises a movable access piece (110) positionable at a plurality of positions. A sensor (130) is mounted relative to the access piece, and the access piece (110) is slidable to reveal the sensor. When the access piece (110) is in the closed position, the sensor (130) is completely enclosed and thereby protected from impacts. To access the sensor (130), the user slides the access piece (110) to an open position using the finger (120) he wishes to place on the sensor. When the access piece (110) reaches the fully opened position, the fingerprint is aligned with the sensor (130). The access piece (110) is made from a conductive material, and it is also electrically grounded. Since the user must touch the access piece (110) to reveal the sensor (130), the user is electrostatically discharged before accessing the sensor.

WO 00/021439 A3

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# A PROTECTIVE ENCLOSURE FOR SENSOR DEVICES

## FIELD OF THE INVENTION

The present invention relates to enclosures for sensor devices, and more particularly to a protective enclosure which aligns an object placed on a biometric sensor.

## BACKGROUND OF THE INVENTION

Biometric-oriented personal identification techniques are becoming increasingly important in protecting personal property, such as laptop computers and cellular phones, preventing credit card and calling card fraud, limiting access to security areas, computers and information, and ensuring security for electronic commerce. Biometric identification techniques use physical traits, measurements and characteristics specific to an individual. These characteristics include, but are not limited to, voice prints, hand prints, fingerprints, retina patterns, and signatures. Typically, biometric identification and verification techniques compare an individual's stored biometric data (the enrolled data) against newly obtained biometric data when the individual desires use of a protected item, access to a protected area or access to protected information. Due to its inherent nature, biometric data has the advantage of always being available for user identification and verification.

The fingerprint biometric is one of the most widely used and researched biometric identification techniques. Existing technology allows the relevant features of a fingerprint to be represented in a few hundred bytes of data. Furthermore, the

computer hardware required for recording and comparing fingerprint data can be centralized and accessed through a telecommunications network, centralized databases and processing hardware, with the result that costs may be amortized across many more transactions than would be the case for distributed processing.

There are, however, disadvantages to biometric identification and verification. For instance, biometric sensors are susceptible to damage from impacts. Also, solid-state biometric sensors are susceptible to damage from electrostatic discharge. In fingerprint identification, the sensor may be particularly susceptible to electrostatic discharge, because the user touches the sensor during the sensing operation.

There are also problems associated with acquiring an accurate image of the fingerprint when an individual desires to access a protected item. In a typical enrollment procedure, the user centers the core of the fingerprint on the sensor, because the core provides desirable identification characteristics. Due to the relatively small size of most fingerprint sensors, often as small as 0.6 inches x 0.6 inches (150 mm x 150 mm), little, if any, of the rest of the fingerprint is sensed by the sensor. During an access procedure, users instinctively place their finger tips on the sensor. When a user places a portion of a fingerprint on the sensor which does not overlap the enrolled image, access will be denied due to finger placement error.

Accordingly, a device is needed for protecting the sensor from impacts, from electrostatic discharge and from other potentially harmful foreign materials, such as dust, dirt, sunlight and liquids. There is also a need for a device and method for aligning a finger on the sensor to ensure overlap with the enrolled image.

## SUMMARY OF THE INVENTION

The present invention increases accuracy and reliability of biometric identification and verification techniques while protecting a sensor from harmful impacts and electrostatic discharge. Such protection and increased accuracy and reliability are achieved by providing an enclosure comprising a movable access piece made from a conductive material. When the access piece is positioned to reveal the sensor, the walls of the enclosure, together with the access piece, cause the user to properly align the object of interest (usually a finger) with the sensor. Protection from electrostatic discharge is achieved by grounding the access piece, which the user must move to reveal the sensor. When the sensor is not in use, the access piece is closed, protecting the sensor from harmful impacts.

In an exemplary embodiment, the present invention encloses a biometric sensor for sensing fingerprints. The sensor is mounted relative to an access piece, and the access piece is slidable to reveal the sensor. When the access piece is in the closed position, the sensor is completely enclosed. To access the sensor, the user slides the access piece to an open position using the finger he wishes to place on the sensor. When the access piece reaches the fully opened position, the desired portion of the fingerprint is aligned with the sensor. The access piece is made from a conductive material, and it is electrically grounded. Since the user must touch the access piece to reveal the sensor, the user is electrostatically discharged before accessing the sensor.

## BRIEF DESCRIPTION OF THE FIGURES

For a better understanding of the present invention, reference may be had to the following description of exemplary embodiments thereof, considered in conjunction with the accompanying drawings, in which:

FIG. 1A shows one view of an exemplary enclosure;

FIG. 1B shows a cross-sectional view of the enclosure of FIG. 1A;

FIG. 1C shows another cross-sectional view of the enclosure of FIG. 1A;

FIG. 1D shows a top view of the enclosure of FIG. 1A;

FIG. 1E shows another view of an exemplary enclosure;

FIG. 2 shows a side view of an exemplary enclosure;

FIG. 3 shows a top view of an exemplary enclosure;

FIG. 4A and 4B show a side view and a perspective view of an exemplary enclosure;

FIG. 5A, 5B, 5C and 5D show a top view of an exemplary enclosure with an access piece positionable at a plurality of positions;

FIG. 6 shows a fingerprint image enrolled according to a method of the invention;

FIG. 7 shows a flow chart illustrating one exemplary method of operating a sensor according to the invention; and,

FIG. 8A and 8B show another exemplary embodiment.

## DETAILED DESCRIPTION OF THE DRAWINGS

The present invention provides an apparatus and method for enclosing and operating a biometric sensor. An enclosure according to the invention protects the sensor from harmful impacts, from electrostatic discharges (ESDs) and from other harmful material and electromagnetic energy. In the preferred embodiment, the enclosure protects a biometric sensor used for sensing fingerprints, and the enclosure is configured to cause a user to align the fingerprint core with the sensor during an access procedure. The enclosure of the invention is also used during enrollment, and a method is provided for enrolling and reconstructing a fingerprint image which increases the likelihood of image overlap during an access procedure. Also, an apparatus is provided for indicating to the user when a fingerprint image of adequate quality is captured.

The preferred embodiment of the enclosure according to the invention is shown in FIG. 1A. The enclosure 100 comprises an access piece 110 which is shown in the closed position. The access piece 110 is a sliding door, and is movable in the direction of the arrows 112 and 114. A cross-section of the enclosure 100 with the access piece 110 in a closed position is shown in FIG. 1B. A sensor 130 is mounted in the enclosure 100 such that the closed access piece 110 covers the sensor 130, thereby protecting it from impacts. An exemplary embodiment of a fingerprint sensor device 130 that can be used in conjunction with the present invention is explained in

U.S. Patent Application "Capacitive Fingerprint Sensor Device With Adjustable Gain," filed May 13, 1997 describing a method and an apparatus for detecting a fingerprint from a finger surface. The apparatus includes a planar array of capacitive sense elements disposed on a substrate. It also includes an insulating and receiving surface disposed over the array of sense elements, which is adapted to receive a finger so that a sense element and a portion of the finger surface located thereabove create a measurable change in capacitance. The capacitance is measured by first pre-charging each sense element, and then using a known current source to remove a fixed amount of charge from each capacitor plate. After a fingerprint is acquired, the quality of the fingerprint is evaluated, and if necessary, a gain parameter for the sense elements is iteratively adjusted until a satisfactory fingerprint is acquired.

Operation of the enclosure 100 is described with reference to FIG. 1A, FIG. 1B and FIG. 1C. A user accesses the sensor 130 by placing a finger 120 on the access piece 110 and moving it in the direction of the arrow 112. In this position, the sensor 130 is fully revealed, as shown in FIG. 1C, and the finger 120 has access to the sensor 130. The finger 120 will then be disposed on the sensor 130 in a proper position and the sensing operation may proceed. A spring (not shown) attaches the access piece 110 to the enclosure 100 such that the access piece 110 closes (is returned to the closed position) when the user releases the access piece 110.

To overcome the hazards of ESD to the sensor 130, especially during an access procedure, the access piece 110 is made of a conductive material and is electrically grounded. When a user touches the access piece 110 to access the sensor

130, the user is grounded through the access piece 110. Because the finger 120 must continue to apply pressure to the access piece 110 to overcome the force of the spring, the finger 120 remains grounded throughout the sensing operation. Once the user releases the access piece 110, it automatically closes, thereby enclosing the sensor 130.

One exemplary spring configuration is shown in FIG. 1E. The spring 180 is a coil spring with elongated ends, each end having a hook. At one end, the spring 180 is hooked to a coupling protrusion 181 on the access piece 110. The other end is hooked to the enclosure 100 at an aperture 183. When the spring 180 is relaxed (that is, not under tension), the access piece 110 is closed. To open the access piece 110, the user must overcome the force of the spring 180. Upon release, the spring 180 returns the access piece 110 to the closed position.

As shown in FIG. 1E, the enclosure further comprises means for mechanically fastening the enclosure 100 to some other device, such as a laptop computer. In the illustrated embodiment, the fastening means include a locating pin 189 and fastening holes 187 and 189. The locating pin 189 fits in a corresponding hole in the device of interest to locate the enclosure 100 in the desired position. Fastening holes 187 and 189 are configured to accept a corresponding fastening means, such as a screw.

A switch 160 attached to the enclosure 100 is also provided. Preferably the switch 160 is operable to switch power to the sensor on and off. The switch 160 is positioned relative to the access piece 110 so that the access piece 110 engages the switch when the user slides the access piece 110 to access the sensor (not shown).

When the user releases the access piece 110, the spring 180 causes the access piece 110 to return to the closed position. After the movement to the closed position, the access piece 110 disengages the switch 160 thereby turning off power to the sensor (not shown).

It is another advantage of this enclosure 100 that the access piece 110 is configured to stop in a position which aligns the finger 120 with the sensor 130. Referring to the cross-section of the access piece shown in FIG. 1B, the access piece 110 is shaped to form a fingertip contour 113. As a user approaches the enclosure 100 to access the sensor 130, the user intuitively touches the access piece 110 in this contoured area 113 with the finger tip, because the fingertip naturally fits into the area 113. As shown in FIG. 1C, when the access piece 110 is moved to an open position with the fingertip placed in the contoured area 113, the top of the finger 120 extends beyond the sensor 130 and the fingerprint core is aligned with the sensor 130.

Lateral alignment of the finger 120 on the sensor 130 is shown with reference to FIG. 1D. The enclosure 100 comprises guides 122 and 124 spaced apart by a predetermined width, preferably the width of the finger 120. In the enclosure 100, the guides 122 and 124 are molded plastic walls. To accommodate fingers of various sizes, the walls may also be slanted inwardly from top to bottom; that is, toward the sensor. When the user places the finger 120 on the sensor 130, the guides laterally align the finger 120 on the sensor 130. The alignment provided by the access piece 110 in the open position and by the guides 122 and 124 enhances accuracy and reliability in acquiring the fingerprint image by minimizing finger placement error.

Of course, the access piece may be configured in various ways to protect sensors designed for various uses. For instance, with reference to FIG. 2, a side view of an enclosure 200 comprising a hinged 202, 204 and 206 access piece 210 is shown. The access piece 210 is made from a conductive material, and it is positionable at a closed position 212 and an open position 214. In the closed position 212, a sensor 220 is covered, protecting it 220 from impacts. To move the access piece 210, the user pushes the piece 210 with his finger to the open position 214. The same previously described alignment and grounding features may be provided.

The top view of another embodiment is shown in FIG. 3. The enclosure 300 comprises a rotatable access piece 310 which is positionable at a closed position 312 and at an open position 314. The user operates the access piece 310 by rotating it with his finger about a pivot 311 to the open position 314. The sensor 316 is revealed when the access piece 310 is at the open position 314. As in the preferred embodiment, the access piece 310 is electrically conductive to ground, and is configured to return to the closed position when the user releases the access piece 310.

Still another configuration is shown in FIG. 4A. An enclosure 400 comprises a housing 410 with an access end 412 and a closed end 414. The housing 410 protects a sensor 420 from impacts when the sensor 420 is not in use. An access piece 430 covers the access end 412. The access piece 430 is made from a conductive material and is swingable between a closed position (not shown) and an open position. The user accesses the sensor 420 by pushing on the access piece 430 with his finger. The access piece 430 is grounded, thereby protecting the sensor 420 from ESD.

Preferably, the housing 410 is shaped such that a finger placed within the housing is laterally aligned with the sensor 420. In this embodiment, the closed end 414 of the housing 410 acts as a stop, causing the user to align his finger with the sensor 420 such that the core of the fingerprint is on the sensor 420.

A perspective of this configuration is shown in FIG. 4B. Walls 413 and 415 laterally constrain the finger (not shown) such that the finger is laterally aligned on the sensor 420. The closed end 414 acts as a constraint causing the fingerprint core to locate on the sensor 414. The access piece 430 is grounded to protect the sensor 420 from electrostatic discharge.

In still another configuration, the sensor is mounted in a slidable unit. As shown in FIG. 8A and FIG. 8B, the enclosure 800 comprises a sliding unit 810. In the closed position, the sliding unit 810 resides within the enclosure 800 and the sensor 820 is protected. An access piece 812, which is a button in this configuration, is operable to cause the sliding unit 810 to slide out of the enclosure 800. The means for sliding the sliding unit 810 into and out of the enclosure 800 may be a spring or motor. As in the prior configurations, the button 812 is electrically conductive to a ground. The user is grounded when he presses the button 812 to release the sliding unit 810. An enclosure edge 817 constrains the finger in one direction and sliding unit edges 819 and 821 constrain the finger in a second and third direction.

An enclosure according to the invention is also provided with an access piece positionable at a plurality of positions. Referring to FIG. 5A, an enclosure 500 is shown with an access piece 510 in a closed position, completely covering the sensor

(not shown). The enclosure also comprises a stopper 530 which is operable to stop the access piece 510 at an open position. An arrow 535 marks a position on the enclosure 500, and a "1" and a "2," or other such alignment marks, mark two positions on the access piece 510. By aligning the access piece 510 markers "1" or "2" with the arrow 535, the access piece 510, in this case a sliding door, is positionable at multiple predetermined positions.

This multiple position capability enables capture of different portions of the fingerprint during enrollment. Enrollment is the procedure by which a fingerprint image is captured and stored as computer accessible data. In FIG. 5B, the enclosure 500 is shown with the access piece 510 positioned at position "1." Only the tip of the finger 540 extends beyond the sensor 520, and the finger 540 and sensor 520 are positioned such that the top of the fingerprint image may be captured. FIG. 5C shows the relative positions of the sensor 520, access piece 510 and finger 540 when the access piece 510 is at position "2." The finger 540 is positioned such that the fingerprint core is centered on the sensor 520, permitting capture of this portion of the fingerprint. In FIG. 5D, the access piece 510 is pushed to the stopper 530, and the finger 540 and sensor 520 are positioned such that an image of the bottom of the fingerprint may be captured.

This procedure enables enrollment and reconstruction of a fingerprint image which comprises the combination of the images captured in position "1," position "2," and at the stop 530 position. This reconstructed image is known as a virtual image. This virtual image is advantageously larger than the sensor area. For example, the

virtual image 600 of FIG. 6 was captured and reconstructed according to the just-described procedure. As can be seen, the virtual image 600 is the combination of three overlapping images 611, 612 and 613 each of which is the size of the sensor.

Advantageously, the resulting image 600 has a larger area than the sensor. When a user places a finger on the sensor during an access procedure, alignment errors are overcome by the relatively larger area of the virtual image 600. In other words, the described apparatus and method increases the probability that the portion of the fingerprint placed on the sensor during an access procedure overlaps the enrolled image 600.

The advantages in overcoming finger placement error with the alignment features of the invention are further enhanced with an image quality indicator, which informs the user when an acceptable image has been captured. A method for providing an image quality indicator is described with reference to the flow chart 700 of FIG 7. In a first step 710 of the procedure, the finger is placed on a sensor enclosed with the previously described apparatus. In a process step 720, the fingerprint image is captured. Then the quality of the image is evaluated in a decision step 730, and it is determined whether the image quality is adequate. If the image is adequate, the user is advised in a process step 740 that the image has been captured. When the image is inadequate, control returns to the process step 720 and the procedure is repeated.

For purposes of this quality indicator feature of the present invention, it is unimportant how an image is captured. Image capturing and storing techniques are well known in the art. Similarly, the image quality may be measured in many ways.

For instance, contrast is one know attribute commonly used for evaluating an image; the image is evaluated by how well the intensity range of the image stretches over the maximum intensity range available. Image evaluation is described in W.K. Pratt, "Digital Image Processing," Wiley Press, New York, New York, 1978, pp. 307-318. The process step 740, which informs the user that the image quality is adequate, may also be implemented with various methods and apparatus. For instance, the indication ,may be audible, such as a beep emitted from a speaker, or visual, such as in lighting an LED.

Numerous modifications and alternative embodiments of the invention will be apparent to those skilled in the art in view of the foregoing description. For instance, an enclosure according to the invention is also operable to protect the sensor from dirt, dust or liquids. Similarly, the enclosure and access piece may also comprise a radio frequency shield to protect the sensor from electromagnetic energy. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the best mode of carrying out the invention. Details of the structure may be varied substantially without departing from the spirit of the invention and the exclusive use of all modifications which come within the scope of the appended claims are reserved.

WHAT IS CLAIMED IS:

1. A protective enclosure for a sensor, comprising:

an electrically conductive access piece positionable between a closed position and at least one open position, said access piece substantially covering the sensor at said closed position and said access piece substantially revealing the sensor at said open position; and,

means for grounding said access piece, wherein an object is substantially grounded upon contacting said access piece.

2. The enclosure of claim 1 further including means for returning said access piece from said open position to said closed position when said access piece is released.

3. The enclosure of claim 2 wherein said means for returning comprises a spring coupled between said access piece and said enclosure, wherein said spring is relaxably coiled when said access piece is at said closed position and said spring is under tension when said access piece is at said open position.

4. The enclosure of claim 1 wherein said access piece is rotatable between said closed position and said open position.

5. The enclosure of claim 1 wherein said access piece is slidable between said closed position and said open position.

6. The enclosure of claim 1 wherein said access piece is swingable between said closed position and said open position.

7. The enclosure of claim 1 wherein said access piece comprises at least one hinge.

8. The enclosure of claim 1 wherein the enclosure is operable to align the object on the sensor.

9. The enclosure of claim 8 wherein said open position is predetermined to align the object with the sensor in a first position.

10. The enclosure of claim 8 wherein the enclosure further comprises means for aligning the object on said sensor in a second position.

11. The enclosure of claim 8 wherein said means for aligning the object on said sensor in said second position further comprises:

a first guide; and,

a second guide, said first guide and said second guide operable to provide alignment for the object on said sensor in said second position.

12. The enclosure of claim 1 wherein said means for grounding said access piece comprises a conductive means electrically connected between said access piece and a ground.

13. The enclosure of claim 1 further comprising a means indicative of image quality.

14. The enclosure of claim 13 wherein said means indicative of image quality comprises:

a processing means for capturing an image;

a decision making means for determining when a quality criteria for said image exceeds a predetermined level; and

a means for informing a user when image quality above said predetermined level has been achieved.

15. The enclosure of claim 14 wherein said means for informing a user when said image quality has been achieved comprises a sound generating device operable to emit a sound when said image quality criteria exceeds said predetermined level.

16. The enclosure of claim 14 wherein said means for informing a user when said image quality has been achieved comprises a light generating device.

17. The enclosure of claim 1 wherein said access piece is positionable at a plurality of positions.

18. The enclosure of claim 1 further comprising a radio frequency shield for protecting the sensor from electromagnetic energy.

19. The enclosure of claim 1 further comprising a switch disposed relative to said access piece, said switch operable to couple the sensor to a power source when said access piece is at said open position and to decouple the sensor from said power source when said access piece is at said closed position.

20. A method for operating a biometric sensor, comprising the steps of:

providing an enclosing means for enclosing said sensor; and,

providing an electrostatically grounded access piece disposed relative to said sensor, said access piece positionable at a closed position and at least one open position, wherein said sensor is substantially covered when said access piece is at said closed position and wherein said sensor is substantially revealed when said access piece is at said open position.

21. The method of claim 20 comprising the further step of moving said access piece from said closed position to said open position to substantially reveal said sensor, wherein said access piece and said enclosing means are operable to align said object on the sensor.

22. The method of claim 20 comprising the further step of returning said access piece from said open position to said closed position.

23. The method of claim 21 wherein said moving step comprises the further step of coupling the sensor to a power source.

24. The method of claim 22 wherein said returning step comprises the further step of decoupling the sensor from a power source.

25. A method for enrolling an image of an object using a biometric sensor, comprising the steps of:

dividing said object into a plurality of portions;

aligning the object on the sensor such that the sensor senses at least one of said portions;

capturing a portion image, said portion image being an image of said at least one portion;

repeating said aligning step and said capturing step until a predetermined number of said portion images are captured; and,

constructing a representation of the image from said portion images.

26. The method of claim 25 wherein said aligning step further comprises the steps of:

providing an enclosing means for enclosing said sensor; and,

providing an access means to said sensor, said access means and said enclosing means operable to align said object on said sensor at a plurality of positions.

27. A protective enclosure for a sensor, comprising:

a sliding unit positionable between a closed position and at least one open position, wherein the sensor is substantially covered at said closed position and the sensor is substantially revealed at said open position;

an electrically conductive access piece operable to cause said sliding unit to move from said closed position to said open position; and,

means for grounding said access piece, wherein an object is substantially grounded upon contacting said access piece.

28. The enclosure of claim 27 further including means for moving said access piece between said open position and said closed position.

29. The enclosure of claim 28 wherein said means for moving comprises a motor.

30. The enclosure of claim 27 wherein said open position is predetermined to align the object with the sensor in a first position.

31. The enclosure of claim 27 wherein the enclosure further comprises means for aligning the object on said sensor in a second position.

32. The enclosure of claim 27 wherein said means for grounding said access piece comprises a conductive means electrically connected between said access piece and a ground.

33. The enclosure of claim 27 further comprising a switch disposed relative to said sliding unit, said switch operable to couple the sensor to a power source when said sliding unit is at said open position and to decouple the sensor from said power source when said sliding unit is at said closed position.

FIG. 1A

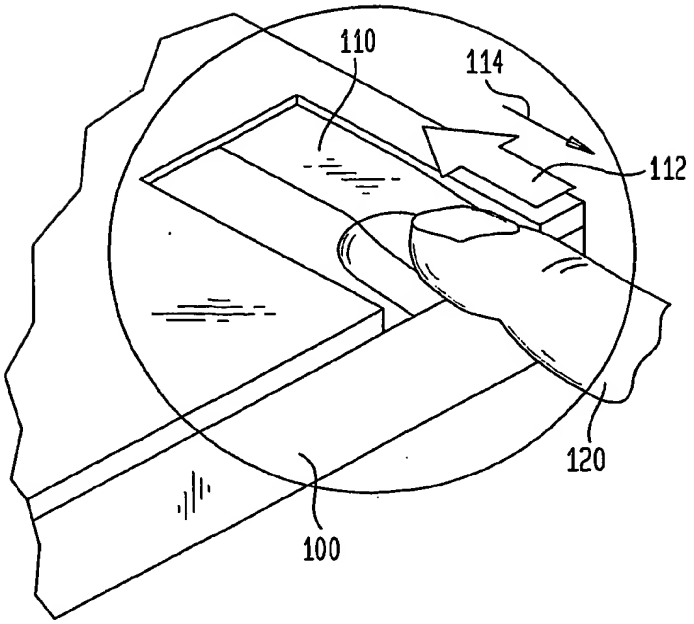



FIG. 1B

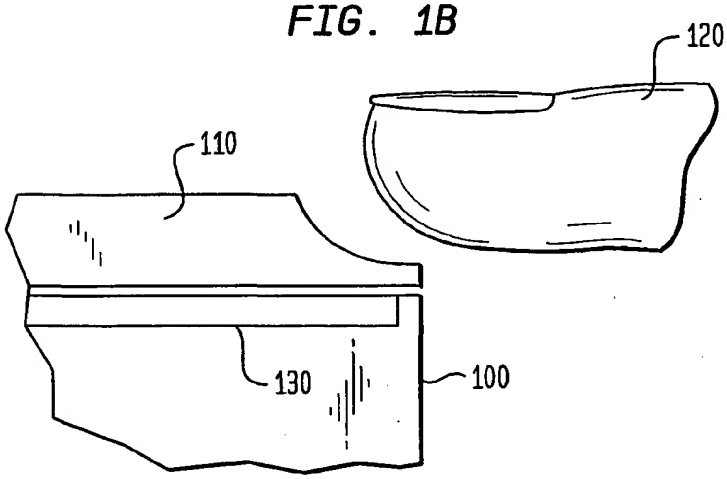



FIG. 1C

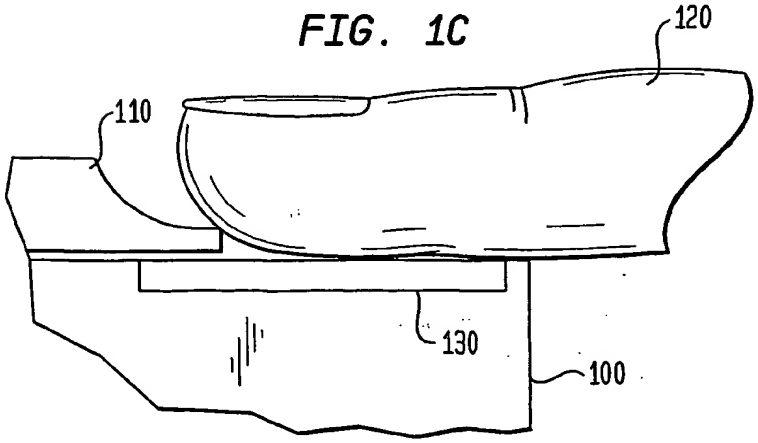


FIG. 1D

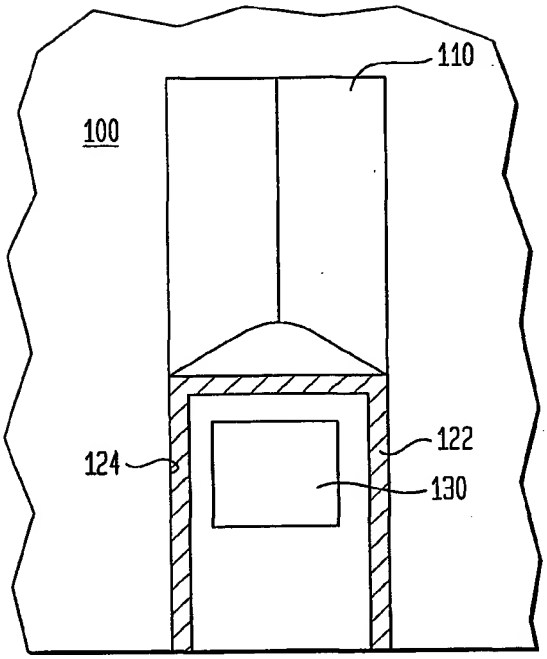



FIG. 1E

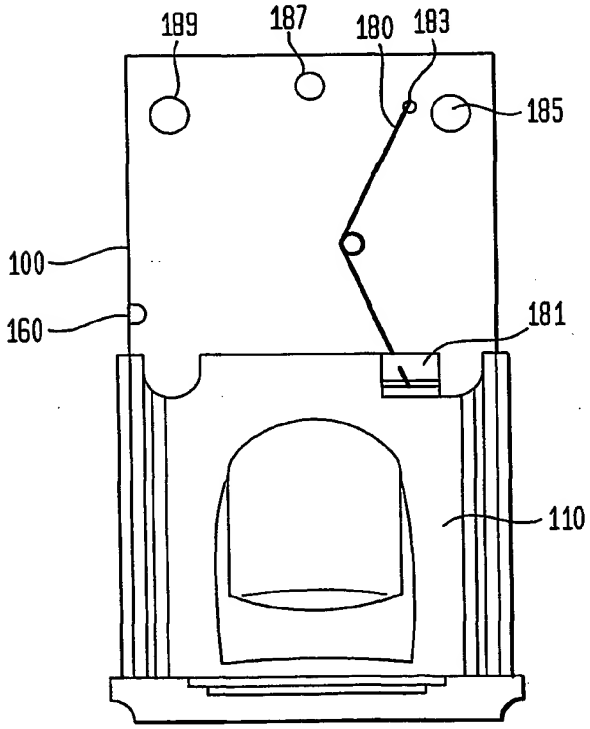


FIG. 2

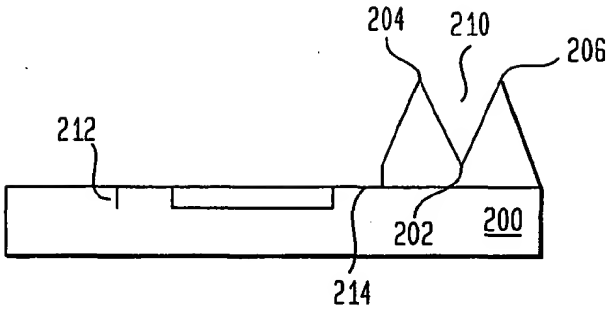



FIG. 3

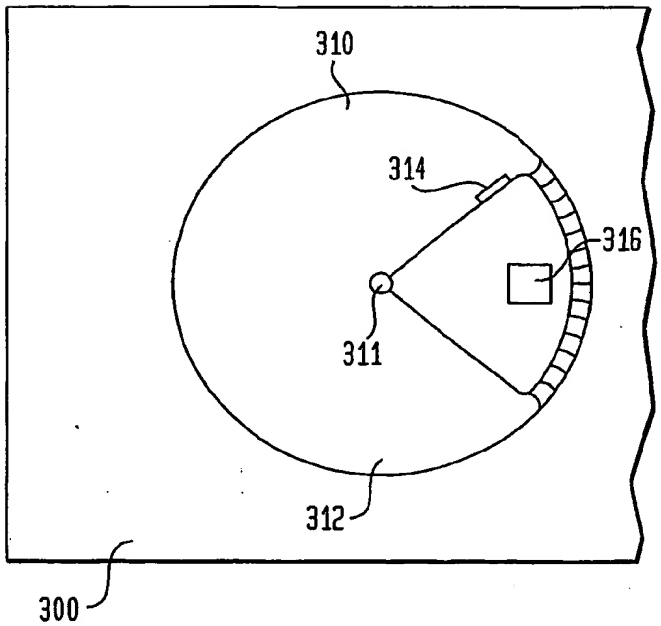


FIG. 4A

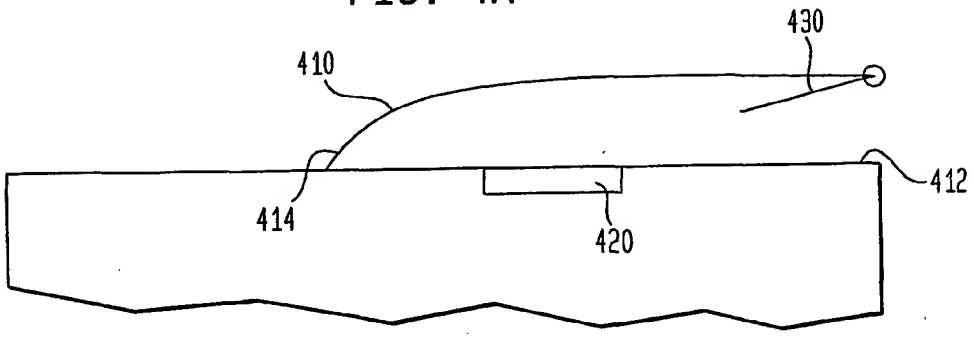



FIG. 4B

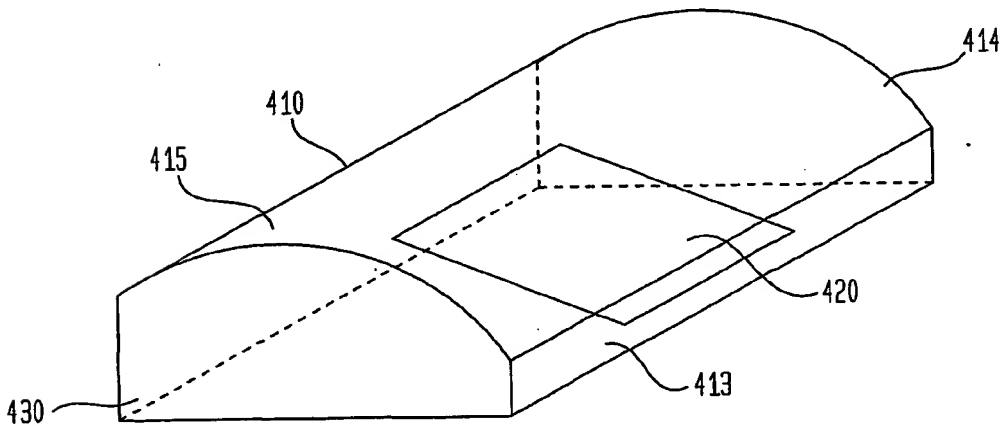


FIG. 5A

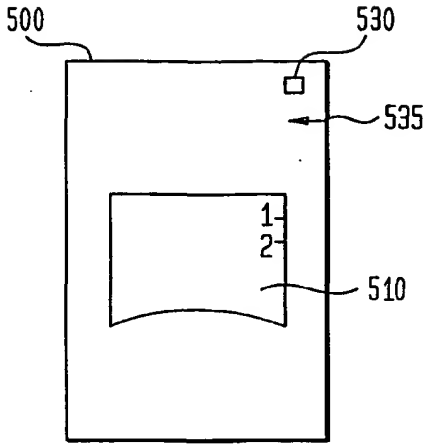



FIG. 5B

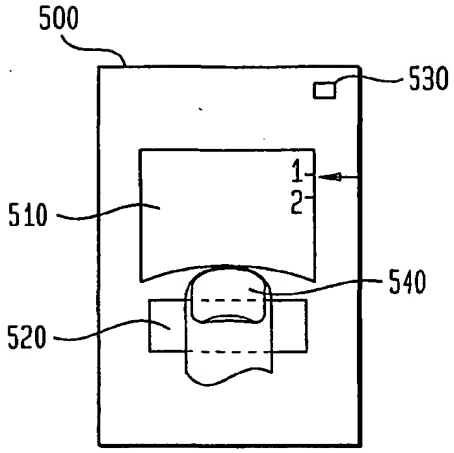



FIG. 5C

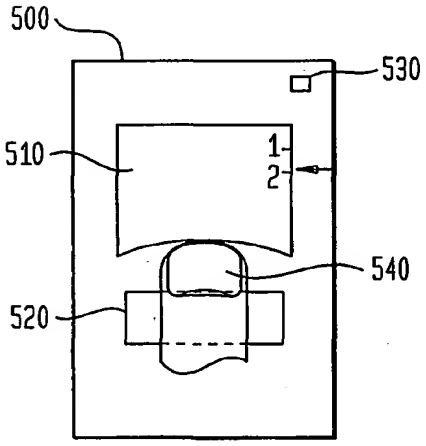



FIG. 5D

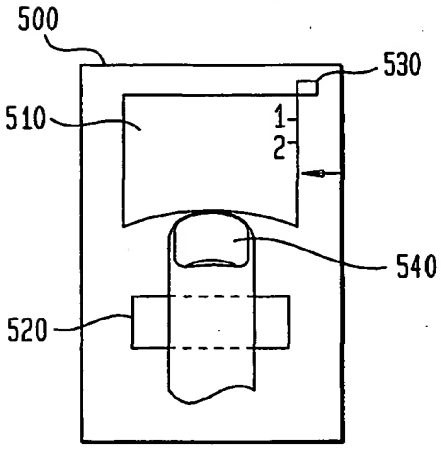


FIG. 6

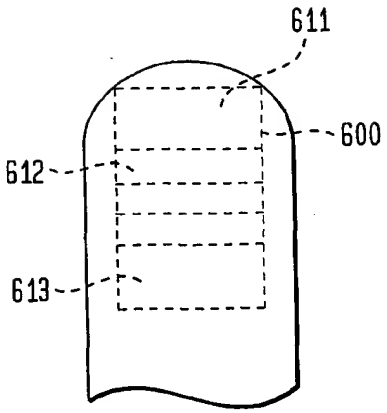



FIG. 7

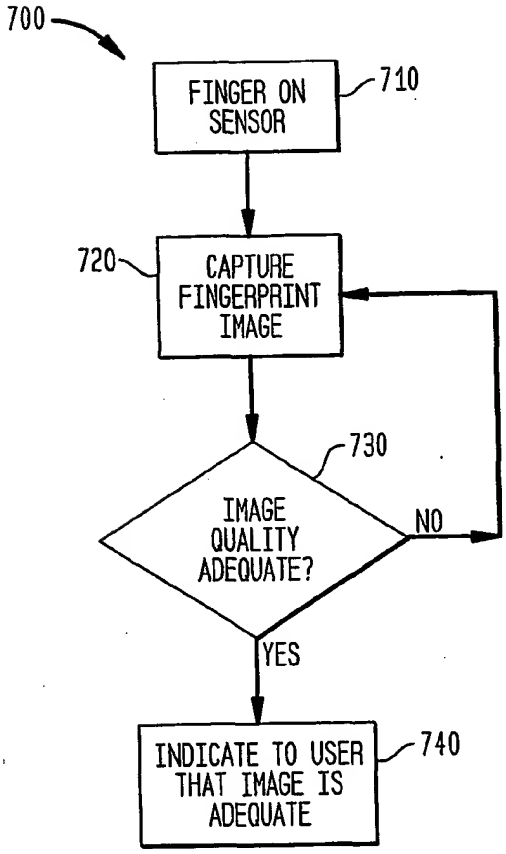


FIG. 8A

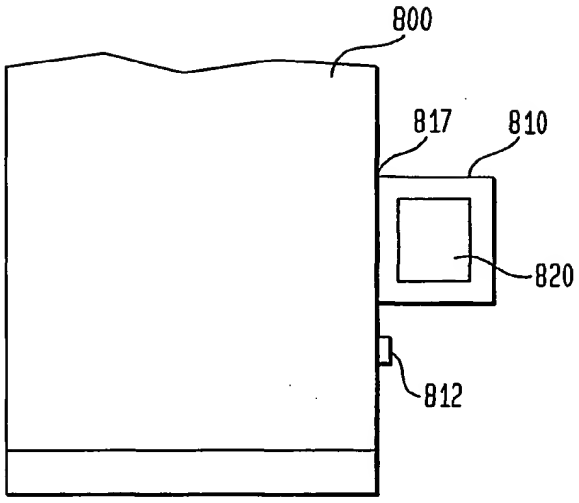
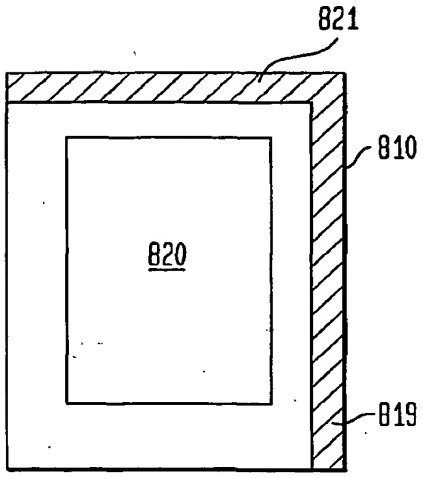



FIG. 8B



# INTERNATIONAL SEARCH REPORT

Int nal Application No
PCT/US 99/23473

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B5/117

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B G07C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 3 804 524 A (JOCOY K ET AL)<br>16 April 1974 (1974-04-16)<br>column 2, line 29 -column 4, line 4<br>column 6, line 6 - line 20 | 1,20,27 |
| A | GB 1 267 996 A (IDENTIMATION CORP)<br>22 March 1972 (1972-03-22)<br>page 3, line 15 - line 28<br>page 3, line 52 - line 80 | 1,20,27 |
| X | US 5 177 802 A (FUJIMOTO YOSHIJI ET AL)<br>5 January 1993 (1993-01-05) | 25,26 |
| A | column 22, line 7 - line 68 | 1,20,27 |
| A | EP 0 813 164 A (THOMSON CSF)<br>17 December 1997 (1997-12-17)<br>column 9, line 17 -column 10, line 3 | 1,20,25,<br>27 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 19 May 2000 | 08. 06. 2000 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Knüpling, M |

Form PCT/ISA/210 (second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

national application No.
PCT/US 99/23473

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-24,27-33

   A protective enclosure for a sensor

2. Claims: 25,26

   A method for enrolling an image of an object

# INTERNATIONAL SEARCH REPORT

Information on patent family members

In ınal Application No
PCT/US 99/23473

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 3804524 A | 16-04-1974 | NONE | |
| GB 1267996 A | 22-03-1972 | AT 308435 B | 15-05-1973 |
| | | BE 732862 A | 10-11-1969 |
| | | CH 501280 A | 31-12-1970 |
| | | CS 177014 B | 29-07-1977 |
| | | DE 1923891 A | 20-11-1969 |
| | | DK 144233 B | 25-01-1982 |
| | | FR 2008282 A | 16-01-1970 |
| | | IE 33076 B | 06-03-1974 |
| | | JP 55051579 B | 25-12-1980 |
| | | NL 6907111 A,B, | 12-11-1969 |
| | | NO 126897 B | 09-04-1973 |
| | | SE 358292 B | 30-07-1973 |
| | | US 3576538 A | 27-04-1971 |
| US 5177802 A | 05-01-1993 | JP 4242486 A | 31-08-1992 |
| | | JP 2579375 B | 05-02-1997 |
| | | JP 3256185 A | 14-11-1991 |
| | | JP 2799054 B | 17-09-1998 |
| | | JP 4092990 A | 25-03-1992 |
| | | JP 4120671 A | 21-04-1992 |
| | | JP 2796428 B | 10-09-1998 |
| | | JP 4190470 A | 08-07-1992 |
| EP 0813164 A | 17-12-1997 | FR 2749955 A | 19-12-1997 |
| | | CA 2206825 A | 14-12-1997 |
| | | CN 1172308 A | 04-02-1998 |
| | | JP 10091769 A | 10-04-1998 |